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A Comparison of Two Systems for Distributing Spare Parts

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LMI

March 1993

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Prepared pursuant to Department of Defense Contract MDA903-90-C-0006.

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PREFACE

The Air Force Distribution and Repair in Variable Environments (DRIVE) model is designed as an improvement over the Uniform Materiel Movement and Issue Priority System (UMMIPS) in the wholesale-to-retail distribution of reparable spare parts. This report describes and quantifies the possible improvements achieved when DRIVE is used.

The principal benefit offered by DRIVE is the ability to determine precisely and accurately the Air Force unit that has the "greatest need" for an item. That greatest need is based on current best estimates for the unit's peacetime and wartime demands and projected assets and the peacetime and wartime availability goals specified by operational commanders.

This report quantifies the benefits of the Air Force's current concept of operations (CONOPS) for implementing DRIVE. It also demonstrates how a modified "push" DRIVE allocation system could provide significant improvements over the current DRIVE CONOPS and identifies follow-on efforts that will help bring the Air Force closer to extracting the maximum benefits from the DRIVE program.

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Executive Summary

A COMPARISON OF TWO SYSTEMS FOR DISTRIBUTING SPARE PARTS

The Air Force Materiel Command is implementing the Distribution and Repair in Variable Environments (DRIVE) program, [illegible] was developed to set priorities for depot-level repair and distribution of spare pa[illegible] in a way that better meets the peacetime and wartime needs of Air Force units throughout the world. Our analysis focuses on the distribution component of the DRIVE program and quantifies its advantages over the current Uniform Materiel Movement and Issue Priority System (UMMIPS).

The distribution component of DRIVE relates distribution schedules to specific readiness and sustainability objectives while keeping track of the changing demands and asset status of spare parts in the field. By tracking those changes and providing the capability to modify distribution plans accordingly, DRIVE makes the depot distribution system more responsive and proactive to operational units at Air Force bases than it has been under UMMIPS.

In the process of quantifying DRIVE's responsiveness, we discovered anomalies in the way the current UMMIPS is being implemented and in DRIVE's ability to support other claimants in addition to the units at Air Force bases. Thus, we address three issues:

- Current UMMIPS implementation
- DRIVE's support to other than Air Force units
- DRIVE's ability to support Air Force units.

Our analysis of more than 22,000 requisitions for more than 1,300 national stock number items used in F-15, F-16, and C-130 aircraft found that item managers routinely override the UMMIPS priorities for allocating spare parts among four major claimants: operational units at Air Force bases, the depot overhaul program, foreign military sales, and other Services. Without such item manager intervention,

UMMIPS would have allocated more spares to foreign military sales customers and fewer to the depot overhaul program and units at Air Force bases. That alternative distribution would have resulted in lower aircraft availability than was actually achieved with item manager intervention. Item manager deviations from UMMIPS priorities improved aircraft availability of Air Force units in two ways:

- They changed the range and depth of spares allocated across the four major claimants.
- They provided a better distribution of spares to operational units at Air Force bases.

DRIVE was originally designed to improve the distribution of spares to *units at Air Force bases*. The attempt to use DRIVE software to address the overall problem (by including the *depot overhaul program, foreign military sales, and other Services* as "pseudo" bases and letting them compete with *units at Air Force bases*) exceeds the original design concept and has not been satisfactory because the Air Force has not yet developed adequate criteria for balancing support across the four claimants. Even UMMIPS appears to be inadequate, inasmuch as item managers routinely override its priorities. Until the Air Force develops suitable criteria for balancing support across the four major claimants, we believe it should continue to use current practices to determine how much support *must be* provided to *the depot overhaul program, foreign military sales, and other Services* and then let DRIVE distribute the remaining assets to *units at Air Force bases*.

The DRIVE concept for distributing spare parts to *units at Air Force bases* calls for setting priorities for existing requisitions after giving highest priority to mission-capable (MICAP) requisitions (requisitions for items required to make aircraft capable of flying a mission). This approach has two advantages:

- It would make marginal improvements in aircraft availability in both peacetime and wartime relative to a UMMIPS program that has extensive item manager intervention.
- It would do so without requiring item manager intervention in the case of *units at Air Force bases*, thereby freeing item managers to pay greater attention to other aspects of their job, to include identifying "must fill" requirements for the *depot overhaul program, foreign military sales, and other Services.* (In those aspects, item mangers can do better than DRIVE as currently configured.)

Furthermore, if DRIVE were constrained to set priorities for MICAP requisitions only and were then allowed to push all remaining assets without regard to requisitions (a modified push DRIVE), it could reduce significantly the number of down aircraft relative to what would result from continuing with the current UMMIPS program.

In order to successfully implement such a modified push DRIVE, we recommend the Air Force take the following actions:

- Develop base-specific application data
- Develop policies for lateral resupply that complement both a modified push DRIVE and the retail systems that routinely perform lateral resupply and redistribution
- Re-examine its process for establishing the level of spares (in the D028 Central Leveling System) to determine the proper base and depot support levels that are consistent with both a push system and suitable lateral resupply polices.

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CHAPTER 1

INTRODUCTION

OVERVIEW OF DISTRIBUTION AND REPAIR IN VARIABLE ENVIRONMENTS

The Air Force Materiel Command (AFMC) is currently implementing the Distribution and Repair in Variable Environments (DRIVE) program. That program will be used to set priorities for repairing and distributing spare parts in peacetime and wartime explicitly in accordance with the Air Force's unit-level operational readiness goals. The program can significantly increase the Air Force's ability to meet its operational readiness goals because of its unique features:

- DRIVE is a near-real-time allocation program that combines the latest available estimates of supply and demand for an item to determine priorities for its repair and distribution in a way that compensates for the large uncertainties inherent in the long-term demand projections of the Air Force D041 (*Recoverable Consumption Item Requirements System) process.* That near-real-time capability is essential in managing today's resources for the following reasons:
  - The supply resources we have today are the results of decisions made at least 18 months ago when we were trying to estimate what was going to happen today; we now know what happened and must react to that knowledge.
  - We have better estimates of demands and less uncertainty in the demand projections because we are only projecting several weeks into the future rather than several years.
- DRIVE allocations for repair and distribution are based on specific quantitative assessments of a unit's capabilities measured against a unit's requirements; those assessments are far more discriminating than the current allocation processes.

OBJECTIVE

The full benefits of the DRIVE program are realized when it is used to set priorities for both the repair and distribution of reparable spare parts. The analysis in this report is limited to an evaluation of the distribution component of DRIVE

(which we will refer to as Distribution DRIVE). Thus, our first objective is to understand how well the current system [the Uniform Materiel Movement and Issue Priority System (UMMIPS)] is being implemented within the Air Force and to quantify differences between the way it was supposed to work and how it works in practice.

The main objective of this report, however, is to quantify how Distribution DRIVE will improve the wholesale-to-retail distribution of spares parts over what is currently accomplished under UMMIPS. We measure these improvements in terms of increased peacetime readiness and wartime sustainability of Air Force units relative to the goals for those units.

The final objective is to review the current plans for implementing DRIVE and to identify ways to improve it so that we can realize its maximum benefit.

THE UNIFORM MATERIEL MOVEMENT AND ISSUE PRIORITY SYSTEM

Department of Defense Directive (DoDD) 4410.6 prescribes UMMIPS; its implementation by the Air Force is covered in Chapter 24 of Air Force Supply Manual (AFM) 67-1, Volume I, Part One. That document defines the policies, procedures, and guidelines for assigning a priority designator to requisitions for spare parts from the wholesale-to-retail level. The UMMIPS priority designator is a number from 1 to 15 that corresponds to one of five force/activity designators (FADs), and three urgency of need designators (UNDs). FAD 1 units, for example, are designated as most important in the opinion of the Joint Chiefs of Staff as approved by the Secretary of Defense; FAD 2 units are designated for deployment at the start of a conflict; FAD 3 units are designated for later deployment but before 30 days, and so on. Similarly, UND "A" can only be justified when the shortage renders a unit unable to perform its mission, UND "B" when the mission would be impaired, and so on. Table 1-1 defines the requisition priority designator as a function of the five FADs and the three UNDs.

The AFM 67-1 provides details on how units are assigned a FAD and lists definitions for UNDs "A," "B," and "C." Those UNDs carry with them a standard for the order-and-shipping time (OST) within which the item should be delivered to the requisitioner.

TABLE 1-1

UMMIPS REQUISITION PRIORITY DESIGNATORS

Force/activity designator	Urgency of need designator		
	A	B	C
I	1	4	11
II	2	5	12
III	3	6	13
IV	7	9	14
V	8	10	15

Under UMMIPS, requisitions are then filled in priority order; within a priority, requisitions are filled on a first-come, first-served basis.

DRIVE'S PRIORITIZATION ALGORITHM

The DRIVE program is similar to UMMIPS in that it also establishes priorities on the basis of each unit's mission and current asset position. However, unlike UMMIPS, the DRIVE program is able to set priorities for filling requisitions within UMMIPS priority designators and to adjust automatically the priorities of requisitions over time. It can set priorities within UMMIPS priority designators because its objective function is more fine-grained and takes advantage of the latest available estimates of demand and supply. However, it does not yet set standards for OST.

DRIVE establishes priorities by using an objective function that is the probability of achieving a specified availability goal for each unit in peacetime and wartime. These goals are specified by the operational commanders and are the number of aircraft that are allowed to be classified "not mission capable for supply" (NMCS). That number of aircraft is referred to as the cannibalization threshold (CAT) value for a unit. It has traditionally been set to the difference between the primary aircraft authorized (PAA) and the direct support objective (DSO) for a unit at a specific point in time during a contingency. Thus, for each national stock number (NSN) item, the DRIVE program tries to maximize the probability (P) of having CAT value or fewer aircraft classified as NMCS because of that NSN. The DRIVE program does so by allocating an NSN item to the base that gives the greatest

increase in this probability per unit cost. (Cost in this case is the hours needed to repair the NSN.) For technical reasons, the DRIVE sort value (the value that essentially replaces the UMMIPS priority designator) is actually the change in the logarithm of *P* divided by the cost, in hours, to repair the NSN.

Note that the DRIVE algorithm does the following:

- Maximizes the probability of having fewer than a specified number of aircraft down, which is one part of the total expected number of NMCS (ENMCS) aircraft calculation that assumes full cannibalization. The DRIVE program does not maximize aircraft availability.

- Addresses the balance between peacetime and wartime objectives by a procedure that appears to be the best solution thus far (given the current framework for DRIVE) but could lead to allocating insufficient support for peacetime or too much support for wartime.

- Attempts to achieve the unit goals at each base rather than to maximize total aircraft availability across all bases. Thus, the DRIVE program can bring all units closer to their readiness goals and, at the same time, decrease total aircraft availability. For example, assume that two units with equal numbers of aircraft each have an 85 percent availability goal. Also, assume that the DRIVE program changes the availability of the two units from 84 and 94 percent to 86 and 90 percent, respectively. In that case, both units are now above their availability goal of 85 percent but the average availability across both units has been reduced from 89 to 88 percent.

- Surrenders some fidelity and accuracy in the treatment of common shop replaceable units (SRUs) in order to make the problem solvable within the current DRIVE framework. The DRIVE program, also, does not provide an assessment of expected aircraft availability that results from the allocation.

We addressed the above points in detail in an earlier report.[1] They are enumerated here to highlight the fact that the DRIVE algorithms do not maximize aircraft availability and are not precise representations of what they are trying to model. For those reasons, LMI developed an independent assessment model to analyze the differences between DRIVE and UMMIPS.

[1]LMI Report AF002R1, *An Analysis of Issues Related to Implementing the DRIVE Model*, Salvatore J. Culosi, April 1991.

AN INDEPENDENT ASSESSMENT MODEL

The LMI independent assessment model calculates the expected number of aircraft that will be fully mission capable at each base.[2] The model is based on an assumption of full cannibalization and provides a more accurate calculation and treatment for SRUs that are common to more than one line replaceable unit (LRU). The model is used to calculate the expected number of aircraft at each base in peacetime and at the end of a 30-day wartime period for each of five alternatives to UMMIPS for distributing spare parts. We present details of these five alternatives in Chapter 2.

Since the independent assessment model does not use the same DRIVE algorithms to assess capability, the benefits that we attribute to DRIVE using this model will be less than if we used DRIVE's algorithms as the assessor. Also, since the DRIVE algorithms have the shortcomings described above, the independent assessment model will give a more realistic portrayal of the differences between DRIVE and UMMIPS.

The independent assessment model has been thoroughly reviewed and validated by both LMI and personnel from the Management Sciences Division at AFMC (AFMC/XPS).

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[2]Each base is assigned a stock record account number (SRAN). Thus, a base is sometimes referred to as a SRAN.

CHAPTER 2

APPROACH

THE EXPERIMENT

In comparing DRIVE and UMMIPS, we first define a baseline capability for UMMIPS as it is currently implemented and then calculate the capability that would result from alternative allocations. We compared DRIVE against the baseline UMMIPS in the following areas:

- How well it allocates available spares across Air Force units.
- How well it allocates to claimants other than Air Force units. [These other claimants are the depot overhaul program, foreign military sales (FMS), and other Services and are referred to and modeled as "pseudo" bases in the DRIVE program.]

Since we are concerned only with Distribution DRIVE, we did the following:

- Collected from the Air Force D035 (Stock Control and Distribution System) all distribution data covering the period 1 January 1991 through the end of July 1992 on selected NSN items – those reparable spares that are unique to the F-15, F-16, and C-130 aircraft.
- Collected all backorder records for these NSN items as of the end of July 1992.
- Collected asset data and projected peacetime and wartime demands for all locations from a DRIVE data base dated 3 July 1992. Since the DRIVE asset position at each SRAN includes assets on hand and en route, the 3 July asset position was assumed to include all assets distributed to each SRAN as of 3 July 1992.
- Obtained asset position for 18 July 1992 by adding to the 3 July asset position all assets distributed by UMMIPS from 3 July through 18 July. This result is the baseline asset position from which we calculated the baseline estimates for key performance parameters that are to be compared with those from alternative allocations.

The key performance parameters are listed below. A more detailed discussion of the metrics for each of the last three performance parameters is presented later in this chapter.

- The distribution of spares among pseudo bases and Air Force bases
- Total ENMCS
- ENMCS "excesses," defined as the expected number of ENMCS aircraft above the goal set for each unit in peacetime and wartime
- The distribution of ENMCS excesses across all bases.

Figure 2-1 is a schematic for addressing the DRIVE/UMMIPS experiment. The DRIVE asset position at time t_0 (July 3) was assumed to include all assets on the shelf at a location plus all those that were en route to that location (i.e., requisitions filled on or before t_0 that had not yet arrived at the location). This assumption is totally consistent with the DRIVE data base that specifically identifies en route assets. For each allocation (the baseline and the five alternatives that we describe), we projected an asset position for an OST beyond the end of a 15-day repair period assuming no demands occurred beyond t_0. For the baseline case, this asset position was calculated to be the sum of assets at time t_0 (those identified in the DRIVE data base) plus all requisitions filled between t_0 and t_{15}.[1] The asset position for the alternative allocations assumed that assets distributed on or before t_{15} arrived no later than t_{15} plus OST (18 July plus OST).

Based on these projected assets, we calculated projections of peacetime and wartime ENMCS for the indicated points in time:

- The peacetime projections are for an OST beyond t_{15} (18 July plus OST).
- The wartime projections are for 30 days beyond the peacetime period (t_{45} plus OST, or 17 August plus OST).

[1]The subscript on t indicates the number of days beyond t_0. Thus t_{15} is 15 days beyond 3 July, which is 18 July, and so on.

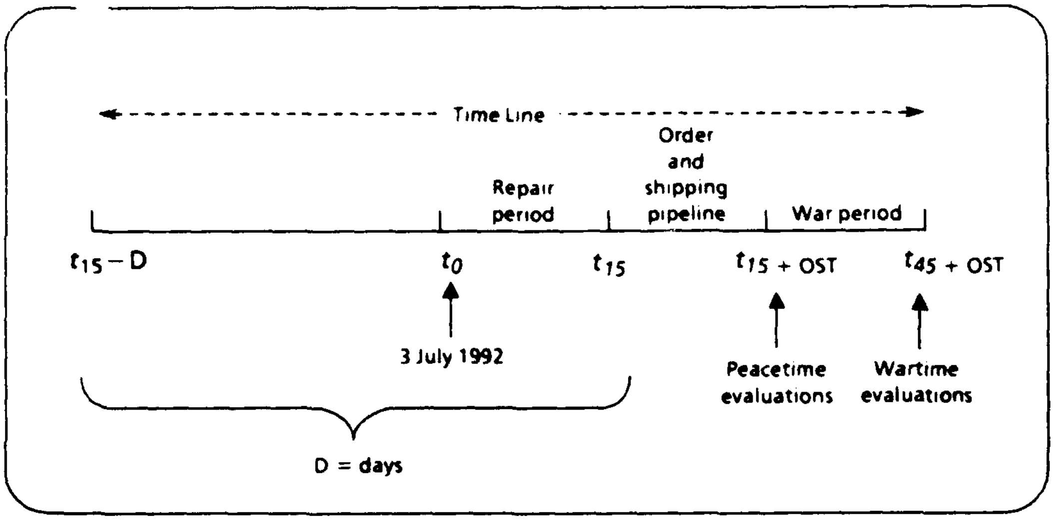

FIG. 2-1. SCHEMATIC FOR ADDRESSING THE DRIVE/UMMIPS EXPERIMENT

This study examined a 90-day case ($D = 90$ in Figure 2-1) and a 270-day case ($D = 270$). For each case, we reallocated, in several ways, all the reparable spares distributed during the period. For example, in the 90-day analysis, we collected all the spare parts that were actually distributed between 19 April 1992 (t_0 minus 75 days) and 18 July (t_0 plus 15 days), and reallocated them in five alternative ways (a pure UMMIPS allocation and four DRIVE alternatives). In the following description of alternatives, the italicized text is the shorthand descriptor used throughout the report to reference the allocation alternatives:

- *Pure UMMIPS.* This alternative allocates spares under a pure UMMIPS criterion with no item manager intervention. Spares are distributed according to UMMIPS priority on a first-come, first-served basis within each priority group designator.
- *Pure DRIVE.* This alternative is a push system that ignores all requisitions.
- *DRIVE Pri-Reqs.* This allocation alternative uses DRIVE to set priorities for all existing requisitions without giving any explicit consideration to mission capable (MICAP) requisitions.
- *DRIVE CONOPS.* This alternative is the current DRIVE concept of operations (CONOPS). Here, DRIVE is used to set priorities for requisitions within the following overriding priority groups:
  - Joint Chiefs of Staff coded MICAPs (requisitions that impact mission capability in that they are required to fill "holes" in aircraft)

- Priority 1, 2, and 3 MICAP, in that order

- All other requisitions.

- *Pure DRIVE Constrained.* This alternative is a modified push DRIVE and a combination of the Pure DRIVE allocation (a total push system) and the DRIVE CONOPS alternatives. It would use DRIVE to set priorities for all MICAP requisitions as in the DRIVE CONOPS but would thereafter ignore all requisitions and would push assets to units.

USING THE DRIVE MODEL TO DEVELOP ALTERNATIVE DRIVE ALLOCATIONS

The normal DRIVE operating mode is to set priorities for the repair and distribution of reparable spare parts. Since we wanted to use DRIVE only to distribute spares, we needed to modify the way we used it as follows:

- Zero out all depot assets for all NSN items

- Run the model in the mode in which repair is constrained by the availability of carcasses but give it a large number of carcasses for each NSN item that was actually distributed during the period.

The process we used for setting priorities for requisitions with the current DRIVE model consisted of searching the DRIVE priority list for the NSN/SRAN combination that matched the requisition and then using the DRIVE sort value as a priority index. In order to ensure that the DRIVE list would contain at least one allocation to each SRAN, we gave DRIVE twice as many carcasses as were actually allocated over a 270-day period. We did not want to run DRIVE in a carcass unconstrained mode because we did not want it to repair NSN items that would not have been repaired and distributed in the real world.

For each case ($D = 90$ and $D = 270$), we ran the DRIVE model once. The output from the model was then used in a postprocessing program to develop each of the four DRIVE alternatives for distributing spares.

SCOPE OF DATA

The results in this report are based on an analysis of over 1,300 NSN items and more than 22,000 requisitions. The backorders on these NSN items totaled more than 23,000. Data for the two cases examined are summarized in Table 2-1.

TABLE 2-1

REQUISITIONS FILLED AND BACKORDER DATA

Data	90 days	270 days
NSN items	827	1,312
Allocations	6,253	22,842
Backorders as of 3 July 1992	19,142	23,104

Table 2-2 presents the total number of aircraft addressed in the study along with the number of SRANs with aircraft and those without aircraft (locations where there are Weapon Training Detached Operating Spares – WTDOS).

TABLE 2-2

AIRCRAFT AND SRAN DATA

Aircraft	Total PAA	SRANs with aircraft	WTDOS	Total SRANs
F-15	715	21	1	22
F-16	1,361	41	20	61
C-130	582	53	41	94

The wartime availability targets at the end of 30 days of combat for each aircraft are 82.8 percent for the F-15, 82.9 percent for the F-16, and 83.0 percent for the C-130.

EVALUATION CRITERIA AND METRICS

The following metrics are used to compare DRIVE and UMMIPS:

- Total ENMCS
- ENMCS excesses, defined as the ENMCS aircraft above the goal set for each unit in peacetime and wartime
- The distribution of ENMCS excesses across all bases.

Table 2-3 presents exemplary data to demonstrate how alternative allocations are compared in this study. In the table, the first column is the number for each base or SRAN, the next column contains the goal for the number of aircraft that are allowed to be down (ENMCS), and the next five columns display the number of ENMCS at each SRAN for each of the example alternative allocations (A, B, C, D, and E).

TABLE 2-3

MEASURES OF EFFECTIVENESS – AN EXAMPLE

SRAN	SRAN ENMCS goal	Total ENMCS for alternative allocations				
		A	B	C	D	E
1	4	12	10	9	8	7
2	4	10	10	9	8	7
3	4	8	10	9	8	7
4	4	2	2	6	5	7
5	4	2	2	1	5	6
Totals	20	34	34	34	34	34
Number of SRANs above goal		3	3	4	5	5
ENMCS excesses		18	18	17	14	14
Root mean squared ENMCS excesses		4.82	4.65	3.97	3.16	2.83

In Table 2-3, the totals show that the total ENMCS for all alternatives is 34. Since all the numbers are the same, we cannot learn anything about the comparative value of these alternative allocations from examining this single metric. If they were not the same, the smaller numbers for total ENMCS would be an indication of a better alternative allocation. We intentionally created this example with equal total ENMCS to demonstrate the value of the other metrics:

- The number of SRANs that have not met their ENMCS goal
- The ENMCS excesses (the number of ENMCS aircraft that are keeping each SRAN from attaining its goal)

- **The root mean squared ENMCS excesses (RMSEE) that is a measure of the distribution of ENMCS excesses across SRANs and is defined as follows:**

$$RMSEE = \sqrt{\frac{\sum_{i=1}^{N} \lambda_i (E_i - G_i)^2}{N}}$$

where:

$$\lambda_i = \begin{cases} 1 \text{ if } E_i \geq G_i, \text{ or} \\ 0 \text{ if } E_i < G_i. \end{cases}$$

E_i = total ENMCS for ith location

G_i = ENMCS goal for ith location

N = number of locations

From Table 2-3 we see that for each of the first two allocations (A and B), 18 aircraft across three SRANs are keeping the units at those SRANs from achieving their goals. On the other hand, the ENMCS excesses for each of the last two allocations (D and E) is 14, and they are distributed over five bases (SRANs). The DRIVE algorithms are designed to move away from Allocation A and toward Allocation E. Note that all these SRANs are assumed to be of equal importance so that we presume that it is better to have the number of "down" aircraft distributed over five bases than to have a less capable force (18 versus 14 ENMCS excesses) distributed over three bases.

In the previous example, the RMSEE metric provides the best representation of the comparative value of each of these alternative allocations because it permits us to discriminate among alternatives that have the same number of total ENMCS (34) and the same number of ENMCS excesses (18 for Allocation A and B, and 14 for Allocation D and E). (Again, smaller RMSEE numbers indicate the better alternatives.) Allocation E has an RMSEE of 2.83, which is 58.7 percent better than the RMSEE of 4.82 for Allocation A. That metric measures the distribution of "hurt" across the bases and best portrays what DRIVE is trying to do.

CHAPTER 3

RESULTS OF THE ANALYSIS

HISTORY VERSUS PURE UMMIPS

Our research showed that item managers routinely deviate from UMMIPS. In Tables 3-1 and 3-2, we compare the allocations that would have been made by UMMIPS with no item manager intervention (Pure UMMIPS) with those that actually occurred in the real world; Table 3-1 shows the results for a 90-day analysis, and Table 3-2 shows the results from a 270-day analysis.

TABLE 3-1

90-DAY COMPARISON OF ACTUAL HISTORY AND PURE UMMIPS ALLOCATIONS

Case data: 6,253 allocations for 827 unique NSN items				
Total UMMIPS allocations	Depot overhaul	FMS	Other Services	Air Force SRANs
Actual history	680	431	265	4,877
Pure UMMIPS (78.9%)	582 (524)[a]	1,045 (370)	281 (229)	4,345 (3,811)

[a] Numbers in parenthesis are the number of items allocated in common with actual history allocations.

Table 3-1 shows that the Pure UMMIPS alternative would have allocated 1,045 items instead of 431 items to FMS with only 370 of those allocations in common with the 431 items actually allocated by the item managers. Table 3-2 shows that the Pure UMMIPS alternative would also have allocated more to FMS over a 270-day period.

On the other hand, a Pure UMMIPS allocation would have provided less support for the depot overhaul program and Air Force SRANs. Table 3-1 shows that the Pure UMMIPS alternative would have allocated only 582 items to the depot overhaul program with only 524 of those items in common with the 680 items actually allocated by the item managers. Across all categories, the Pure UMMIPS

TABLE 3-2

270-DAY COMPARISON OF ACTUAL HISTORY AND PURE UMMIPS ALLOCATIONS

Case data: 22,842 allocations for 1,312 unique NSN items				
Total UMMIPS allocations	Depot overhaul	FMS	Other Services	Air Force SRANs
Actual history	2,275	1,625	1,058	17,884
Pure UMMIPS (89.1%)	2,124 (2,040)[a]	2,718 (1,464)	1,087 (989)	16,913 (15,849)

[a] Numbers in parenthesis are the number of items allocated in common with actual history allocations.

allocation would have had between 78.9 percent (90 days) and 89.1 percent (270 days) of its allocations in common with the actual distributions.

If we look at the allocations to Air Force SRANs alone, we see that the item managers provided more assets than would have been the case with a Pure UMMIPS allocation. A comparison of the aircraft availability (measured in ENMCS) of these two allocations is shown in Table 3-3 (90 days) and Table 3-4 (270 days). Here we see a Pure UMMIPS allocation would have increased the total number of down aircraft by between 2.5 and 28.9 percent. The 2.5 percent is the increase in the wartime ENMCS for the 90-day analysis (Table 3-3); the 28.9 percent is the increase in peacetime ENMCS for the 270-day analysis (Table 3-4).

These reductions in aircraft availability (increases in ENMCS) are the net effect of two separate causes each with their own impact on aircraft availability:

- What is distributed. The differences in the range and depth of the items distributed. These differences are reflected in the total number of items distributed in each case (4,345 versus 4,788 for the 90-day analysis; 16,913 versus 17,774 for the 270-day analysis).
- Where these items are sent.

Thus, Tables 3-3 and 3-4 also show the results for an adjusted Pure UMMIPS allocation. This allocation shows the ENMCS that would have resulted if the same range and depth of spares actually allocated by the item mangers (in violation of UMMIPS priorities) were allocated according to Pure UMMIPS priorities, ignoring the priorities for pseudo bases. The effect of this change alone is less than the total,

TABLE 3-3

ENMCS SUMMARY FOR ALTERNATIVE UMMIPS ALLOCATIONS – 90 DAYS

UMMIPS allocations	Peacetime				Wartime				Items distributed
	F-15	F-16	C-130	Total	F-15	F-16	C-130	Total	
Actual history	51.6	155.8	19.4	226.8	70.6	238.9	23.8	333.3	4,877
Pure UMMIPS	51.0	170.6	21.6	243.3	70.1	245.4	26.0	341.5	4,345
Adjusted Pure UMMIPS[a]	57.4	166.1	21.4	243.8	77.2	242.8	24.8	344.8	4,877
All levels filled[b]	32.3	129.5	15.6	177.4	36.1	201.3	18.3	255.9	20,071
NSN items used in calculation	247	526	54	827	247	526	54	827	

[a] Results if 4,878 items actually distributed to Air Force SRANs were distributed according to Pure UMMIPS, ignoring priorities for pseudo bases

[b] Results if all requisitions are filled and all SRANs have their levels on 3 July 1992

TABLE 3-4

ENMCS SUMMARY FOR ALTERNATIVE UMMIPS ALLOCATIONS – 270 DAYS

UMMIPS allocation	Peacetime				Wartime				Items distributed
	F-15	F-16	C-130	Total	F-15	F-16	C-130	Total	
Actual history	55.8	165.6	23.0	244.5	74.0	247.5	26.8	348.3	17,884
Pure UMMIPS	63.2	220.5	31.5	315.2	81.2	287.7	35.2	404.1	16,913
Adjusted Pure UMMIPS[a]	70.0	201.7	24.2	285.5	88.3	281.2	27.9	397.5	17,884
All levels filled[b]	31.0	134.2	18.1	183.2	34.9	205.7	20.8	261.4	36,480
NSN items used in calculation	444	769	99	1,312	444	769	99	1,312	

[a] Results if 17,884 items actually distributed to Air Force SRANs were distributed according to Pure UMMIPS, ignoring priorities for pseudo bases

[b] Results if all requisitions are filled and all SRANs have their levels on 3 July 1992

combined effects of fewer spares *and* the distribution of these spares to specific locations.

One additional fact: item manager intervention is probably greater than portrayed in Tables 3-1 and 3-2. The commonality numbers in those tables indicate how the final allocations differ, but they do not reflect delays in filling priority requisitions. For example, in Table 3-1, we did not measure how many of the 370 items that were in common with actual history were filled by item managers outside UMMIPS priority sequence. Thus, the item managers could have filled some

of those 370 requisitions after other lower priority requisitions were filled and a Pure UMMIPS allocation might have filled them earlier in accordance with UMMIPS priorities. We did not measure that difference.

DRIVE'S MACRO ALLOCATIONS TO PSEUDO BASES

The DRIVE model was originally intended to set priorities for repair and distribution across Air Force SRANs. To capture the total repair and distribution picture, the concept of pseudo bases was developed to model other (non-Air Force SRAN) claimants for spare parts (the depot overhaul program, FMS, and other Services).

These pseudo bases are modeled as aggregate locations that require NSN items as spares and that the model believes are on the aircraft that must meet a quantifiable aircraft availability goal. The availability goal for these pseudo bases, in the context of the DRIVE objective function, is 100 percent. That is, the model is trying to maximize the probability that the pseudo will have zero aircraft down because of an NSN item at the pseudo base. However, another parameter in the model – the pseudo base goal – permits the user to scale down the demand projection for the pseudo base. Thus, if the DRIVE data base has a requirement for five items over a 2-week period for the FMS pseudo base and the FMS goal is 60 percent, the projected FMS pipeline in the DRIVE model is set to three (5 times 0.6). Against that average requirement of three and zero assets, allocations are made to maximize the probability that the actual FMS demands over the period will not exceed supply. For FMS, the maximum number allocated is capped at the adjusted goal (in this case three).

The logic for the other pseudo bases (depot overhaul program and other Services) is the same as that for FMS except no cap is placed on the allocations for the depot overhaul program. Thus, the DRIVE model could allocate an overly generous "safety level" to the depot overhaul program.

Before running the DRIVE model to see how it would allocate across the pseudo bases and Air Force locations, we examined the input data for the pseudo bases and compared those data with actual allocations. Projections of demand for the pseudo bases in the DRIVE data base were out of line with actual history. Table 3-5 compares the estimate of pseudo base demands (the requirements) in the DRIVE data base with actual history for both the 90-day and 270-day analysis. For the 90-day

analysis, 680 items were actually allocated to the depot overhaul program for 173 out of 827 NSN items distributed during this period. The DRIVE data base showed a depot overhaul requirement of only 420 items (rather than 680) for these 173 NSN items for the 90-day period. The disparity is even greater for the FMS pseudo SRAN. The DRIVE data base showed a requirement of 2,270 against an actual allocation of 431. The differences for 270 days were even greater (10,581 versus 1,625 for FMS).

TABLE 3-5

A COMPARISON OF DRIVE REQUIREMENTS AND ACTUAL ALLOCATIONS

	90 days (827 NSN items)		270 days (1,312 NSN items)	
	Depot	FMS	Depot	FMS
Number of NSN items	173	175	313	383
Actual allocations	680	431	2,275	1,625
DRIVE requirements	420	2,270	1,353	10,581

With those great differences between the DRIVE data base and actual history, it was virtually impossible to expect the DRIVE model to come anywhere near the actual allocations. If we had made the runs with these data, the differences would have been attributed to data and not necessarily the DRIVE model. Also, we know that item managers routinely override the UMMIPS priorities. Since we have no evidence to indicate whether the item managers are doing the right thing, we decided to proceed as follows:

- Using current procedures, we would permit the item manager to determine how much should be allocated to the pseudo bases. We call this the "must fill" requirement for the pseudo bases.
- We would then find out whether the DRIVE model can "set aside" the item manager's "must fill" requirement for pseudo bases.

To determine whether the current DRIVE model could set aside the item manager's assessment of pseudo base needs, we replaced the DRIVE requirement

with the actual history and then ran the model. Table 3-6 shows the results for the 270-day analysis. The top part of the table repeats the data from Table 3-2. The bottom of Table 3-6 shows the results from two DRIVE runs:

- One where all the pseudo base goals are set at 100 percent.
- The other whether the depot goals is set to 60 percent and all the others are set to 100 percent.

TABLE 3-6

A COMPARISON OF DRIVE AND UMMIPS ALLOCATIONS – 270 DAYS

	Depot	Foreign military service	Other Services	Air Force SRANs
Total UMMIPS allocations:				
Actual history	2,275	1,625	1,058	17,884
Pure UMMIPS (89.1%)	2,124 (2,040)[a]	2,718 (1,464)	1,087 (989)	16,913 (15,849)
DRIVE allocations (100% goal for all claimants):				
Pure DRIVE (57.5%)	4,190 (2,257)	1,559 (1,559)	492 (185)	16,601 (9,139)
DRIVE CONOPS (89.4%)	2,454 (2,237)	1,773 (1,574)	914 (880)	17,701 (15,119)
DRIVE allocations (60% goal for depot; 100% for all other):				
Pure DRIVE (73.6%)	2,579 (2,018)	1,501 (1,501)	456 (456)	18,306 (12,855)
DRIVE CONOPS (90.4%)	2,241 (2,112)	1,669 (1,512)	848 (818)	18,084 (16,211)

[a] Numbers in parenthesis are the number of items allocated in common with actual history allocations.

For each run, separated by a dashed line, we show the results for a Pure DRIVE allocation and a DRIVE allocation that reflects the current DRIVE CONOPS. In the case in which all pseudo base goals are 100 percent, Table 3-6 shows that Pure DRIVE (DRIVE unconstrained by requisitions) tends to overallocate to the depot overhaul program at the expense of Air Force bases (SRANs).

In an effort to reduce DRIVE's support to the depot overhaul program, we reduced the depot overhaul goal to 60 percent. Under that condition, we see a better allocation for both DRIVE allocations, but we still overshoot the actual allocation to the depot overhaul program in the Pure DRIVE case.

The problem is that we do not yet know how to set priorities on allocations among the four major claimants: Air Force SRANs, the depot overhaul program, FMS, and other Services. Once we clearly define "rules" for those allocations, we can develop an appropriate algorithm and insert it into the DRIVE program. Until we do that, we propose the following solution:

- Use the item managers to identify what NSNs must be provided to the pseudo bases and how many of each.
- Modify the DRIVE program to ensure that these "must fill" requirements for pseudo bases are given the highest priority in the DRIVE model.

DRIVE'S ALLOCATIONS ACROSS AIR FORCE BASES

In the first section of this chapter, we saw how a Pure UMMIPS allocation, relative to actual history, would reduce aircraft availability across Air Force SRANs. That reduction in aircraft availability results from a combination of the following:

- Fewer total items allocated to all the Air Force bases (SRANs) by Pure UMMIPS
- Item manager deviations to UMMIPS for items that they distributed.

In this section, the Pure UMMIPS numbers are based on the same number of items actually distributed by item managers so that we can compare only the effects of where items would have gone under a Pure UMMIPS allocation, factoring out of our ENMCS analysis the decreases in aircraft availability that would have resulted from allocating fewer spares.

The first column in Figure 3-1 (90-day analysis) [and subsequently in Figure 3-7 (270-day analysis)], shows how a Pure UMMIPS allocation would differ from actual history. The effects on aircraft availability (90-day analysis) are shown in Table 3-7 and Figures 3-2 through 3-6. The table and figures also compare four alternative DRIVE allocations. (The DRIVE alternatives are described in Chapter 2 in the description of the experiment.)

Each of the DRIVE allocations was also constrained to distribute exactly the same number of NSN items that were distributed by the item managers during the period under consideration. The only difference is to whom the items are distributed. In the remainder of this chapter, we present graphically the results of the 90-day and 270-day analyses. The 90-day results are presented first with narrative to explain

the table and figures. The table (Table 3-8) and figures (Figures 3-7 through 3-12) for the 270-day analysis parallel those for the 90-day analysis and are provided at the end of this section for completeness but without comment. The detailed data for both these analyses, including the breakout by aircraft type, is provided in Appendix A.

Results of 90-Day Analysis

Figure 3-1 shows how the overall allocations for each alternative are distributed among the following areas:

- Area 1 represents the number of allocated items that were in common with the actual allocations. For allocations that were not constrained by requisitions (Pure DRIVE and Pure DRIVE Constrained), this category contains allocations against requisitions that were in place at the time the allocations were made.
- Area 2 applies only to items allocated by the Pure DRIVE and Pure DRIVE Constrained alternatives. It shows the number of allocations that DRIVE wanted to push to a location at a time when there were no requisitions in place; the requisitions came in later and were actually those filled by UMMIPS. In other words, Area 2 allocations were common to the actual allocations but could have been allocated earlier by a push DRIVE. This area represents an upper bound to the *number of possible proactive* allocations that might have occurred using DRIVE. Since we are measuring and comparing aircraft availability at the end of the 90-day period, we were not able to capture during the 90-day period the benefits that would have accrued from these possibly proactive allocations.
- Area 3 represents the number of allocations that were made to requisitions that were outstanding (backordered) as of 3 July 1992. As such, those allocations were not in common with actual history.
- Like Area 2, Areas 4 and 5, represent only the Pure DRIVE and Pure DRIVE Constrained allocations. Those allocations were pushed to bases (SRANs) for which there were no outstanding requisitions at any time during the period of the analysis.
  - Area 4 represents those allocations to bases at which the application data are purported to be accurate and based on the specific aircraft at that location.
  - Area 5 refers to those allocations that were pushed to a location at which the base application data *could* possibly be in error. More specifically, they included NSN items that were not in the unit's war reserve spares kits (WRSK) and had an application percent less than 100.

Differences between Areas 4 and 5 provide a measure of the following:

- The extent to which an item was misallocated by sending it to a location that might not have a valid requirement (a concern that is often expressed when a Pure DRIVE is suggested)

- The part of the aircraft availability improvements that could have been erroneously attributed to the fact that DRIVE is postulating demands that do not exist for a particular location.

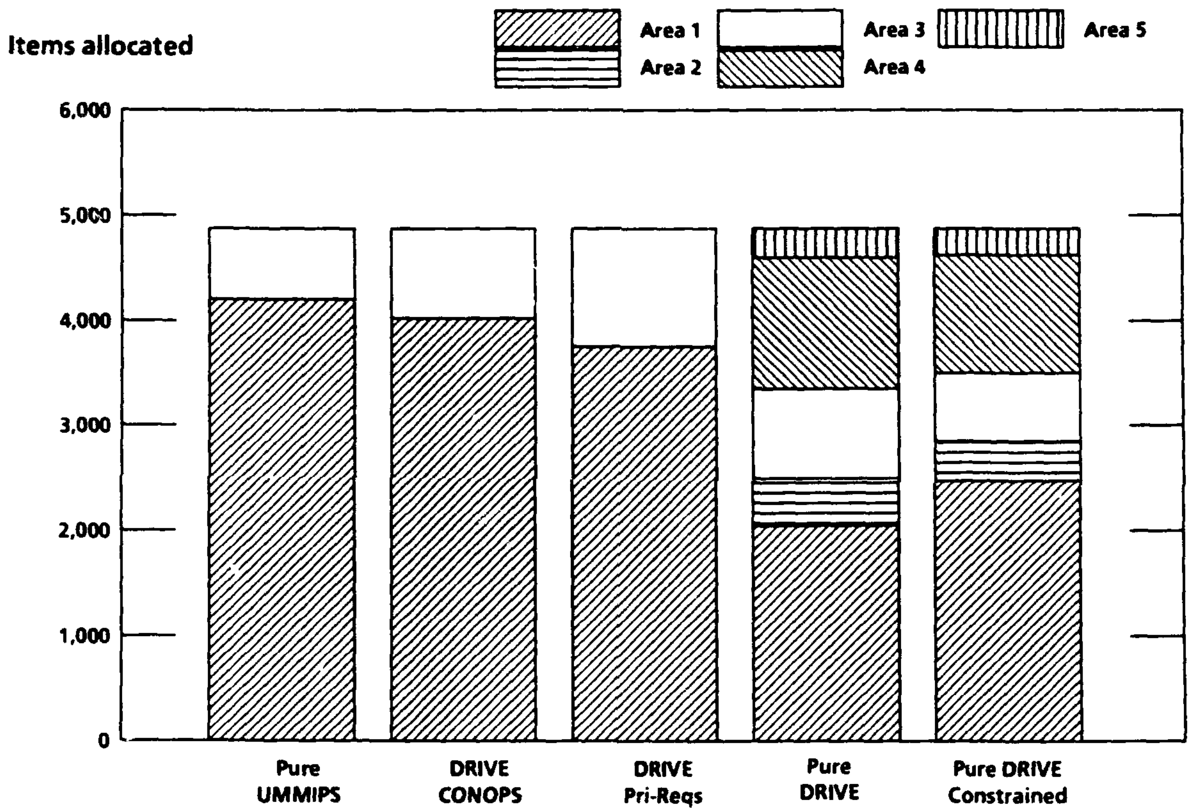

FIG. 3-1. DISTRIBUTION OF ALTERNATIVE ALLOCATIONS – 90 DAYS

As the figure shows, the fraction of the total allocation in Area 5 is small. When we eliminated these spares from the ENMCS calculations (to be shown below), we found insignificant increases in the number of down aircraft. Without these spares, total ENMCS increases by less than 0.1 percent, a truly insignificant amount compared to the 9 to 36 percent decrease in ENMCS that can be obtained from either of DRIVE's push alternatives.

The first column of Figure 3-1 shows that the item manager deviated from UMMIPS more than 13 percent of the time (Area 2 is 667 allocations out of the total 4,877).

On the other hand, Figure 3-1 shows that when DRIVE is constrained by requisitions, between 77 and 82 percent of the allocations are the same as actual history. When DRIVE is unconstrained (Pure DRIVE) or constrained minimally by setting priorities for MICAP requisitions (Pure DRIVE Constrained only)

- 51 to 58 percent of the allocations are in common with actual history
- 28 to 32 percent were pushed to locations that had no requisitions.

Table 3-7 compares the the key measures of effectiveness for the two UMMIPS allocations and the four DRIVE allocations. Figures 3-2 through 3-6 portray graphically the data for each of the rows in Table 3-7. The data in Table 3-7 and the following figures show:

- Actual allocations UMMIPS with item manager intervention), which provided fewer number of ENMCS with generally better distribution of ENMCS excesses than would have been the case if we followed a Pure UMMIPS *allocation.*
- As expected, constraining an optimization model gives poorer results. The order of allocation that reflects increasing constraints on DRIVE is Pure DRIVE, Pure DRIVE Constrained, DRIVE Pri-Reqs, and DRIVE MICAPs. Pure DRIVE has no constraints; DRIVE MICAPs is the current DRIVE CONOPS and is the most constrained alternative. As shown in the these figures, the more we constrain DRIVE, the worse are the result by any criterion.
- The DRIVE CONOPS alternative gives marginally better ENMCS totals than Actuals but does so without item manager intervention. The real benefits of this alternative are shown in a comparison of the wartime ENMCS excesses (Figure 3-5) and RMSEE in Figures 3-4 and 3-6. Those metrics show larger improvements, confirming the hypothesis that DRIVE is more interested in bringing each unit closer to its goals than it is in minimizing total ENMCS.
- A Pure DRIVE allocation makes significant improvements over the current system. For this reason, the Air Force should try to move in the direction of a push system.
- An attempt to mix a purely push system with the requirement to honor MICAP requisitions is reflected in the Pure DRIVE Constrained allocation.

Here again, we see that constraining Pure DRIVE in this way is not as good as a Pure DRIVE, but it is substantially better than the current DRIVE CONOPS.

TABLE 3-7

SUMMARY OF KEY MEASURES OF EFFECTIVENESS FOR ALTERNATIVE ALLOCATIONS – 90 DAYS

Measures of effectiveness	UMMIPS		DRIVE				All levels filled
	Pure	Actuals	CONOPS	Pri-Reqs	Pure	Pure Constrained	
Peacetime							
ENMCS excesses	243.8	226.7	223.5	212.4	193.4	205.5	177.3
RMSEE	2.38	2.26	2.16	2.04	1.83	2.03	1.87
Wartime							
Total wartime ENMCS	344.8	333.2	323.6	315.7	266.8	278.5	255.9
ENMCS excesses	94.5	91.7	85.6	78.1	45.8	56.8	56.5
RMSEE	2.27	2.24	2.15	2.04	1.14	1.41	1.83
No. of SRANs w/excesses	25	24	23	22	20	20	16

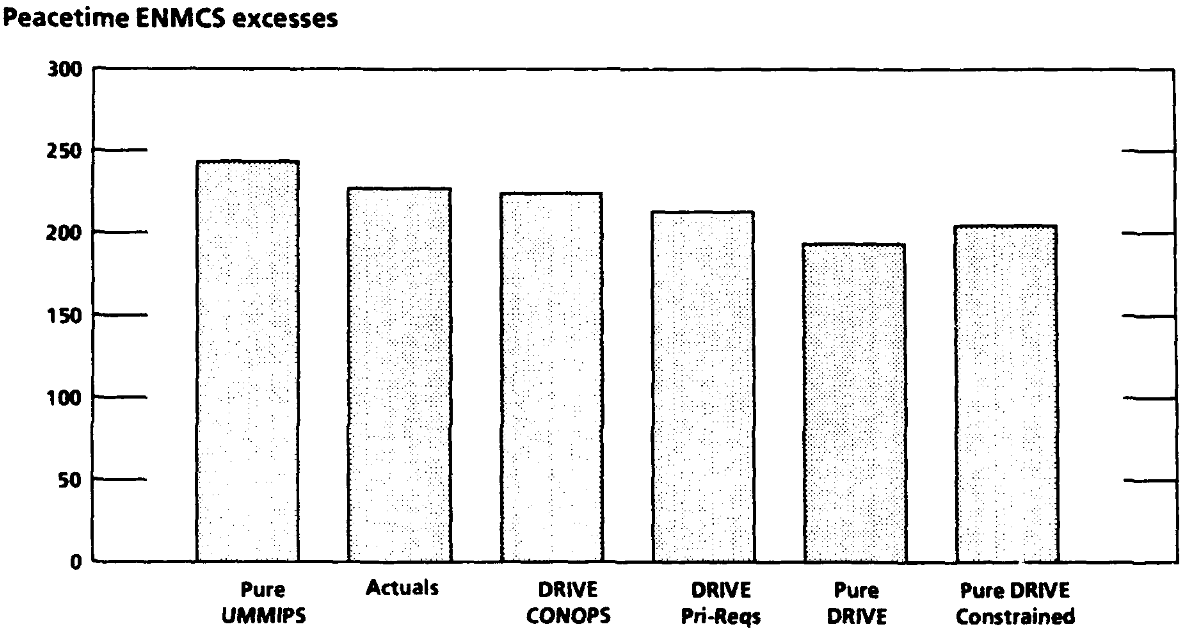

FIG. 3-2. PEACETIME ENMCS EXCESSES FOR ALTERNATIVE ALLOCATIONS – 90 DAYS

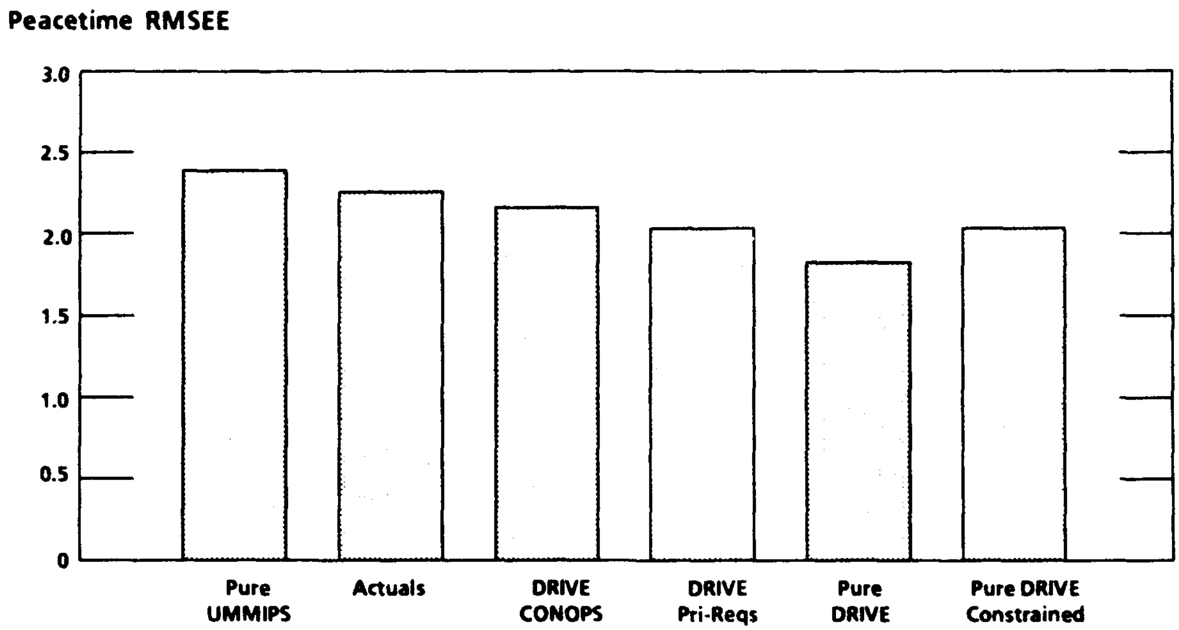

FIG. 3-3. DISTRIBUTION OF PEACETIME ENMCS EXCESSES FOR ALTERNATIVE ALLOCATIONS – 90 DAYS

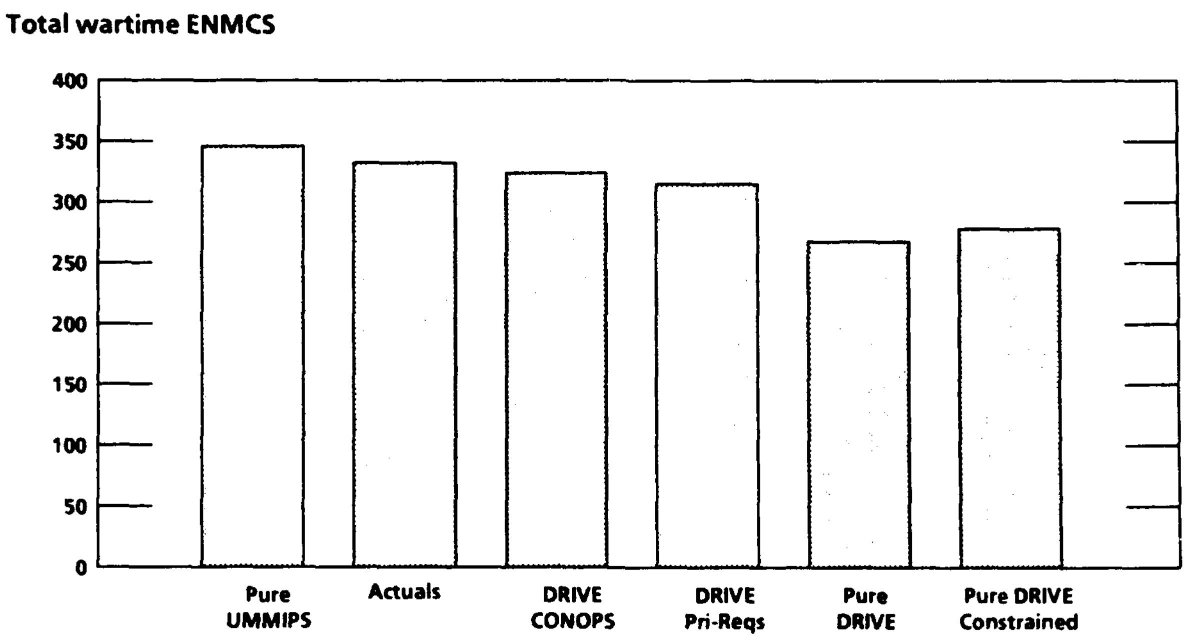

FIG. 3-4. TOTAL WARTIME ENMCS FOR ALTERNATIVE ALLOCATIONS – 90 DAYS

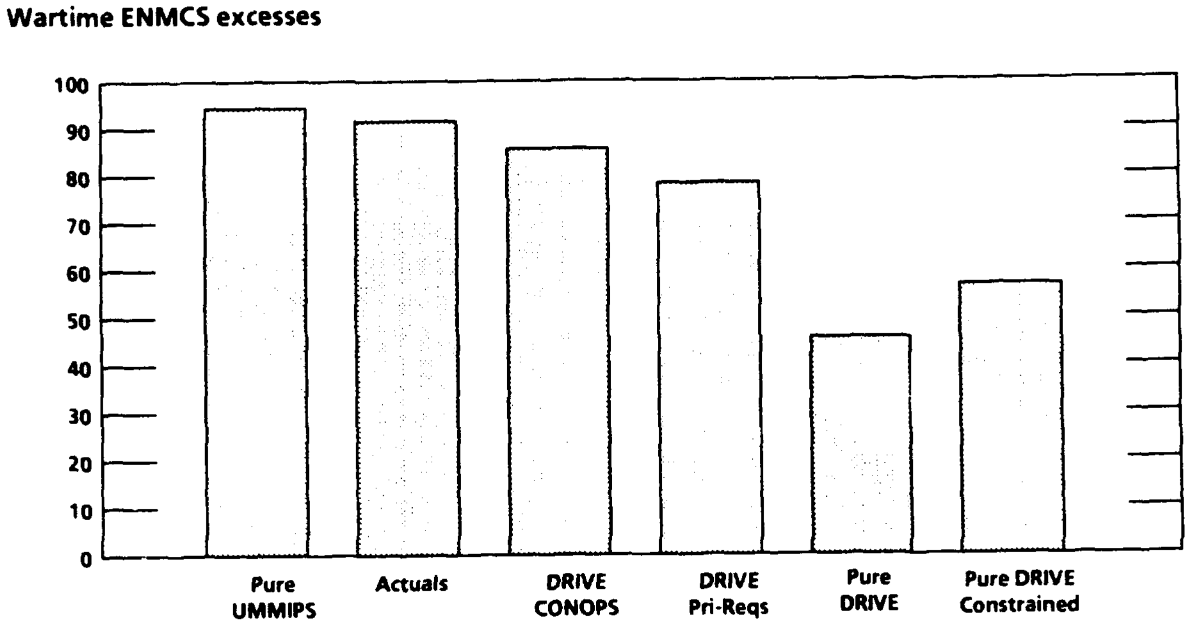

FIG. 3-5. WARTIME ENMCS EXCESSES FOR ALTERNATIVE ALLOCATIONS – 90 DAYS

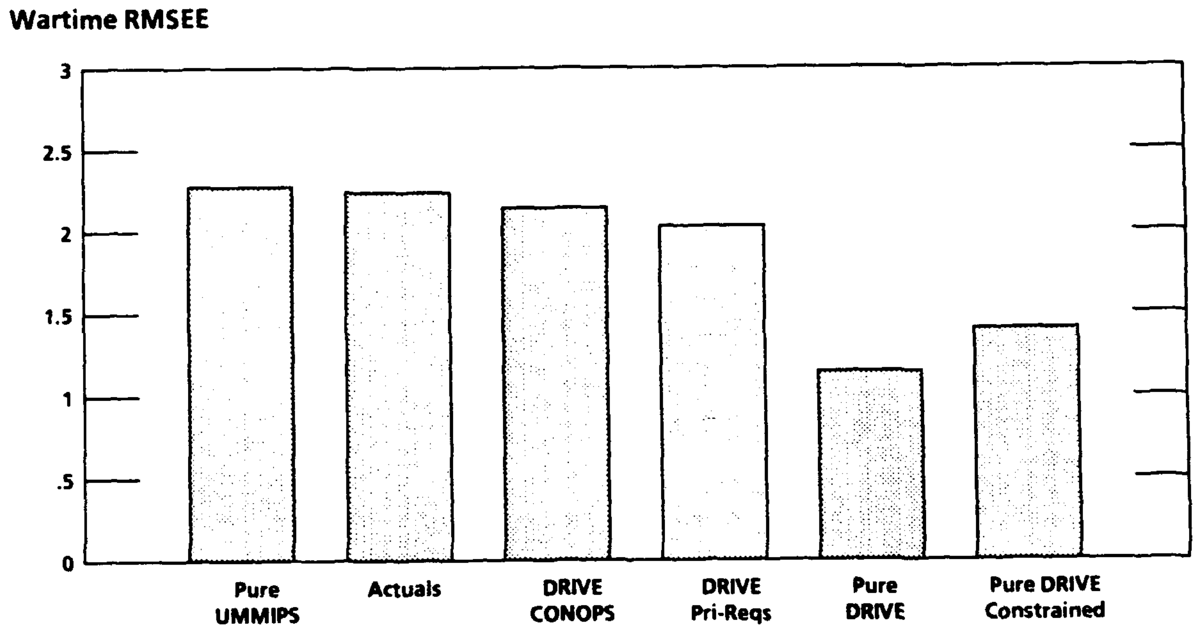

FIG. 3-6. DISTRIBUTION OF WARTIME ENMCS EXCESSES FOR ALTERNATIVE ALLOCATIONS – 90 DAYS

Results of 270-Day Analysis

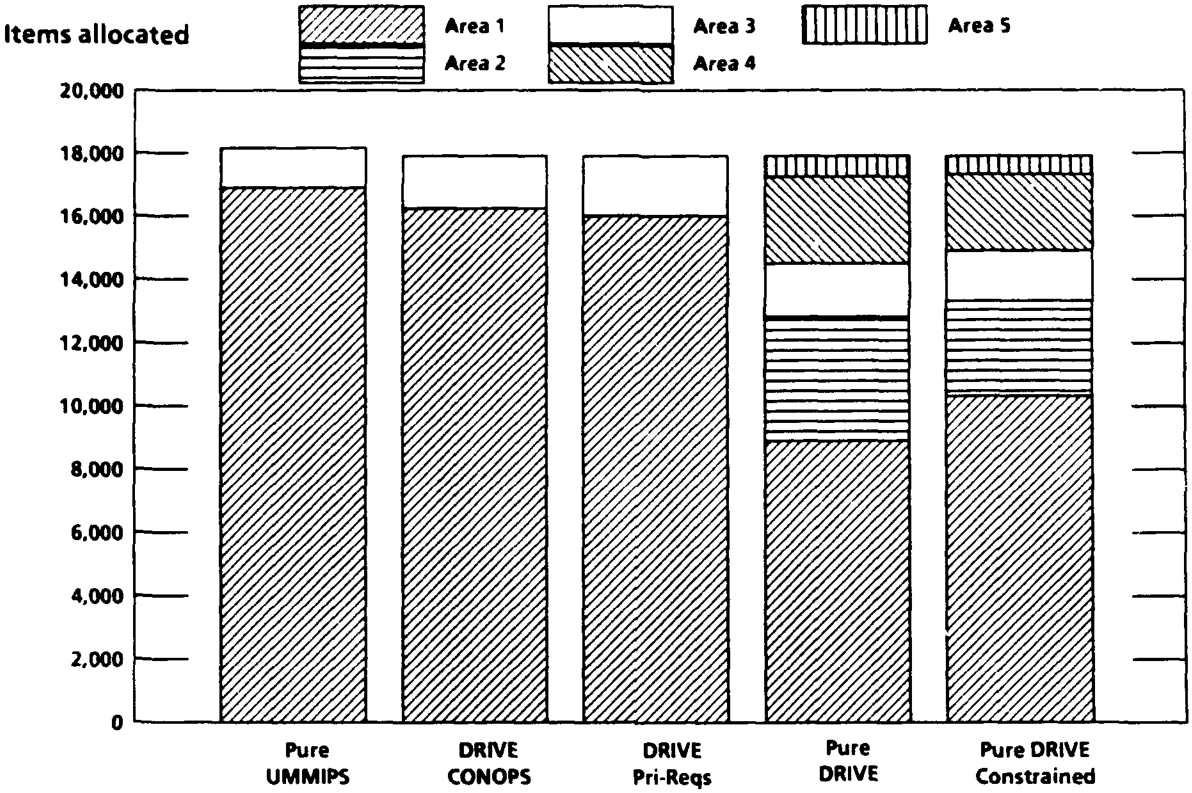

FIG. 3-7. DISTRIBUTION OF ALTERNATIVE ALLOCATIONS – 270 DAYS

TABLE 3-8

SUMMARY OF KEY MEASURES OF EFFECTIVENESS FOR ALTERNATIVE ALLOCATIONS – 270 DAYS

Measures of effectiveness	UMMIPS		DRIVE				All levels filled
	Pure	Actuals	CONOPS	Pri-Reqs	Pure	Pure Constrained	
Peacetime							
ENMCS excesses	296.0	244.5	240.4	228.7	202.0	225.5	183.2
RMSEE	2.86	2.34	2.24	2.13	1.87	2.06	1.89
Wartime							
Total wartime ENMCS	397.5	348.3	345.5	330.6	265.9	289.7	261.4
ENMCS excesses	125.1	97.8	96.3	82.3	43.0	57.2	59.2
RMSEE	2.86	2.40	2.42	2.25	1.45	1.69	1.86
No. of SRANs w/excesses	30	25	25	23	19	22	16

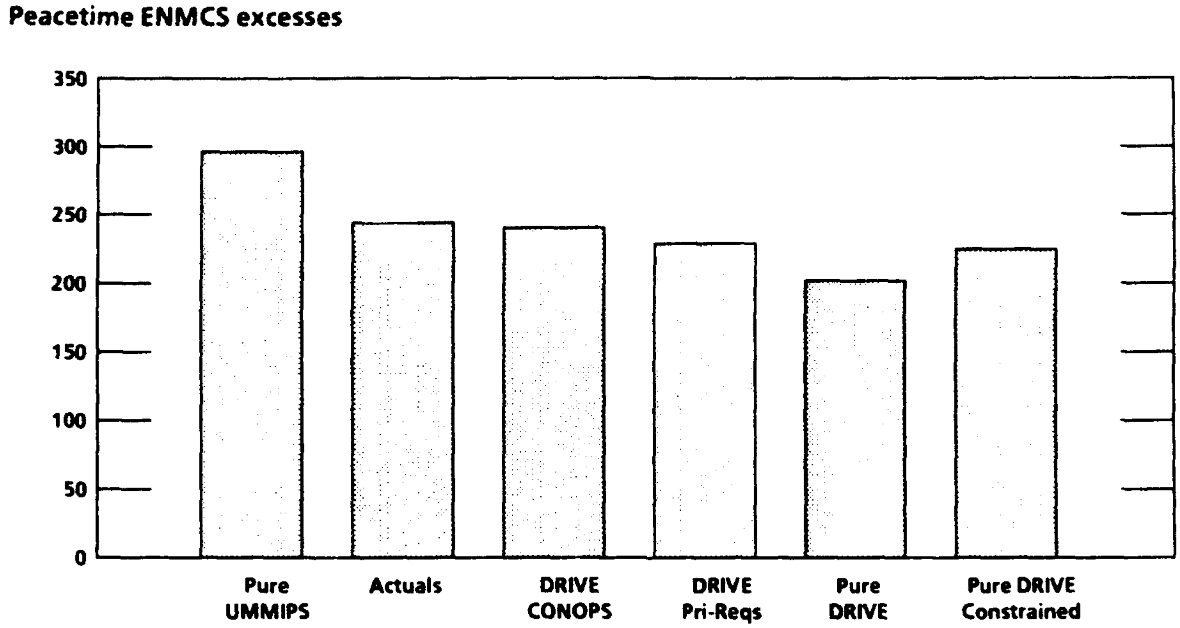

FIG. 3-8. PEACETIME ENMCS EXCESSES FOR ALTERNATIVE ALLOCATIONS – 270 DAYS

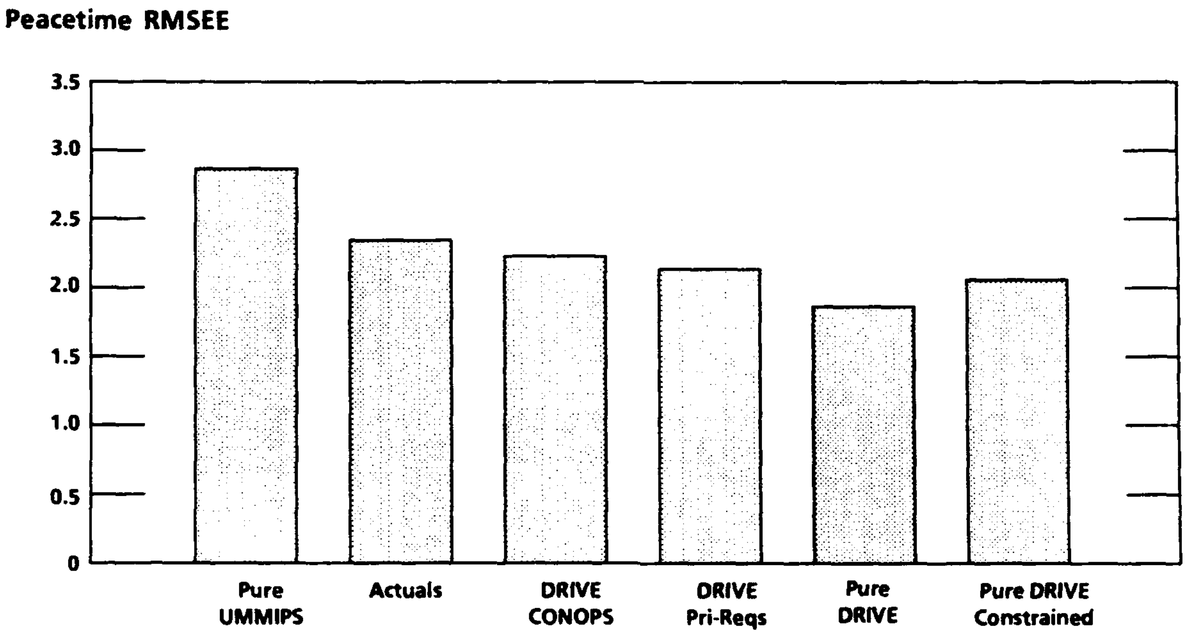

FIG. 3-9. DISTRIBUTION OF PEACETIME ENMCS EXCESSES FOR ALTERNATIVE ALLOCATIONS – 270 DAYS

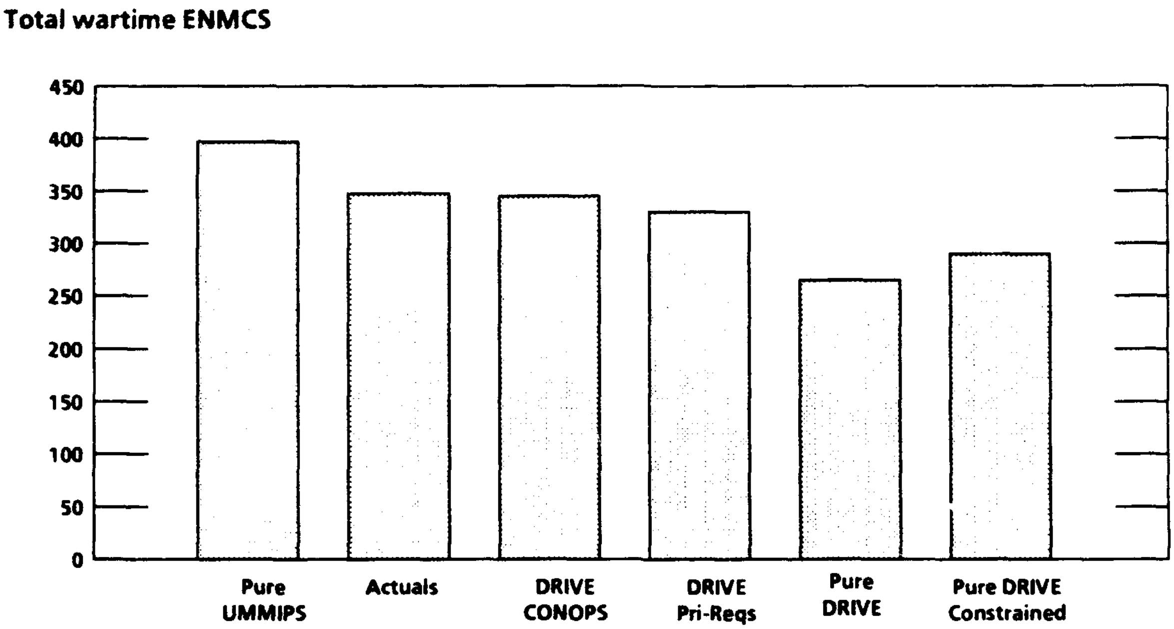

FIG. 3-10. TOTAL WARTIME ENMCS FOR ALTERNATIVE ALLOCATIONS – 270 DAYS

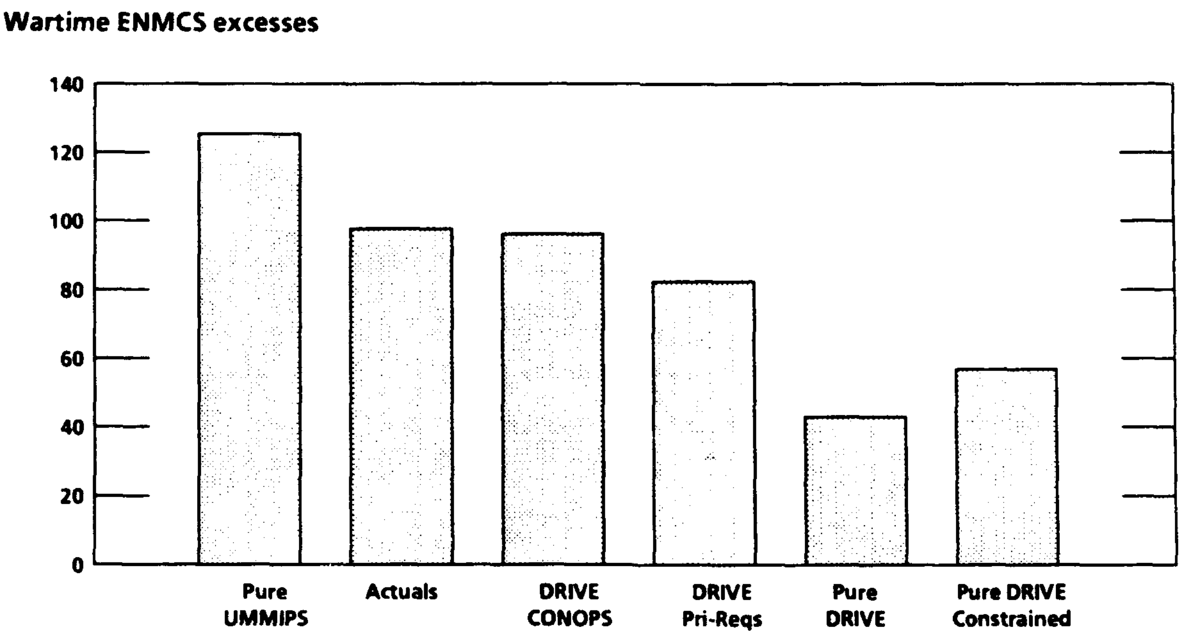

FIG. 3-11. WARTIME ENMCS EXCESSES FOR ALTERNATIVE ALLOCATIONS – 270 DAYS

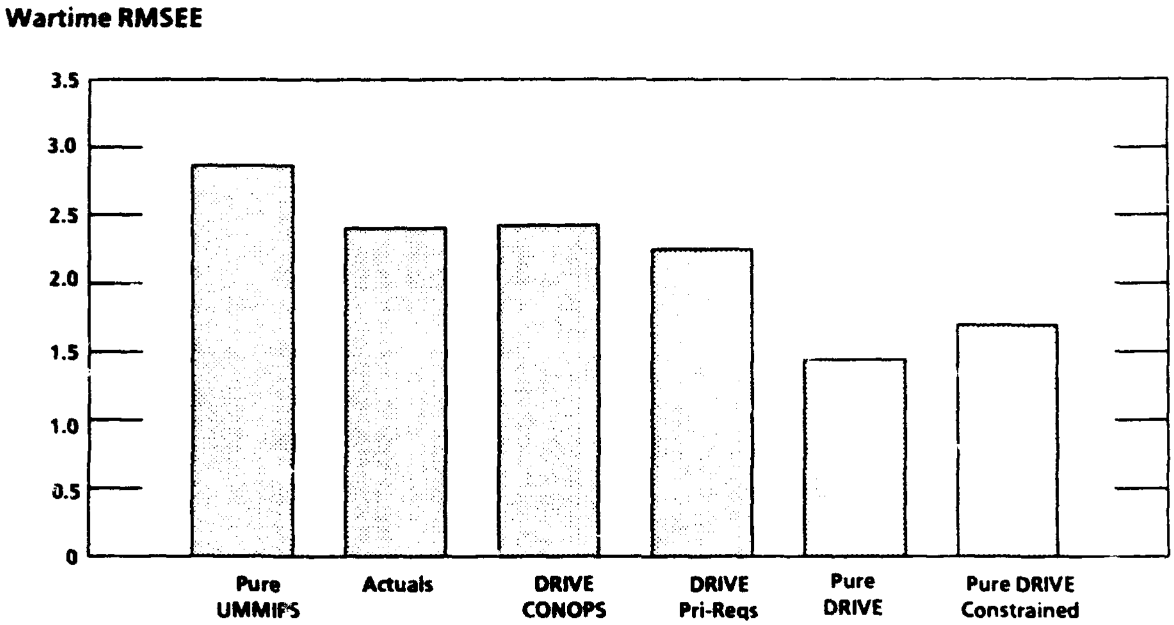

FIG. 3-12. DISTRIBUTION OF WARTIME ENMCS EXCESSES FOR ALTERNATIVE ALLOCATIONS – 270 DAYS

CHAPTER 4

IMPLEMENTATION OF DISTRIBUTION DRIVE

To attain the benefits of DRIVE, the Air Force must develop the following:

- Base-specific application data
- Policies for lateral resupply that complement DRIVE
- A revised level-setting process that is consistent with the DRIVE operating procedures and considers fully the strong dependencies among at least the following:
  - The depot and base support levels
  - The lateral resupply policies
  - The transportation policies that consider costs and criteria for expediting shipments.

BASE-SPECIFIC APPLICATION DATA

A barrier to implementing a push DRIVE system is lack of confidence that the receiving location has a legitimate requirement for the item being pushed. Confidence is eroded because the Air Force does not have reliable base-specific application data for NSN items that are not in the WRSKs. (That problem is separate and distinct from the questions of reliable indenture data that this study presumed was correct.)

Our study identified these push allocations and showed that they did not have a significant effect on the improvements. That is, even if there were no need for these items at the locations to which they were sent, the Air Force still would have done better with a push system. At any rate, even if the costs of developing reliable base-specific application data are too great, several alternatives are available to ensure we are not allocating spares to the wrong location. For example:

- Whenever DRIVE wants to push an item to a certain location, ask the receiving location if the item is stocked there. If not, do not send it.

- If the location stocks the item, then
  - Ask the location to submit a formal requisition and send the item
  - Increase the level at that location and reduce the level of the location that has the lowest priority outstanding requisition for the item.

That procedure will essentially adjust levels "on the fly" while maintaining the same control total for base levels set by D028.

EFFECTIVE/DRIVE-COMPATIBLE LATERAL RESUPPLY POLICIES

Air Force units routinely engage in lateral resupply under the following conditions:

- When the receiving unit is MICAP for the item
- When the issuing unit has a spare part "on the shelf" to issue.

The Air Force uses its MICAP Asset Sourcing System (MASS) to perform that limited lateral resupply. With the enhanced visibility provided by DRIVE, lateral resupply may well be cost-effective under other conditions. One obvious example is the case in which assets are severely maldistributed. In that case, lateral resupply can be used to redistribute those assets and thereby better utilize depot repair capability for items that are in short supply across the entire Air Force rather than simply maldistributed.

With DRIVE's enhanced visibility of assets and projected demands, we may be in a better position to develop improved lateral support policies that would provide greater aircraft availability for a given cost.

REVISED LEVEL-SETTING PROCESS

The current D028 level-setting process determines base and depot levels that will minimize total backorder across all bases. The process is deficient in at least two ways:

- It is based on requirements and not on assets.[1]
- It assumes that no lateral resupply is available.

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[1]LMI Report AF601R4, *Assets vs. Requirements: Why Asset Based Central Leveling Is A Good Idea*, Christopher H. Hanks, August 1987.

Without lateral resupply, depot levels are generally larger than with it because the depot level is designed to reduce depot delays for a spare. With lateral resupply, a unit can sometimes tolerate longer depot delays (lower depot levels) in exchange for a shorter resupply from a neighboring unit.

If the Air Force had no lateral resupply and no peacetime operating stock (POS) level for the depot (the depot would still retain levels for other claimants – depot overhaul, FMS, and other Services), the Air Force aircraft availability might be better at specific points in time but, on average, it would be worse.

For example, the analyses in this report reallocated the same set of spares allocated by UMMIPS. In some instances, item managers, in accordance with UMMIPS, retained spare parts at the depot for two reasons:

- No requisitions were outstanding.
- The depot on-hand assets were below a "MICAP support level" – a level below which the item manager uses assets to fill only MICAP requisitions and permits stock replenishment requisitions to remain unfilled.

If the Air Force had used these additional assets, it would have achieved better aircraft availability at one point in time for some locations but could have increased depot delays at another point in time with possibly degrading effects on readiness depending on the lateral support policies.

With the introduction of "a spare-is-a-spare" policy and the elimination of WRSK protectable levels, the current DRIVE CONOPS will be using DRIVE to prioritize requisitions that were not filled in the past (those above the WRSK protectable level). That policy will essentially remove the "depot POS support level" established by the current D028 and could degrade readiness in the absence of lateral resupply. While the results in this study are for a specific point in time, we need to exercise care in projecting how much better the Air Force will be over time. In order to maximize support capability over time, the Air Force should develop a revised level-setting process that is consistent with the DRIVE operating procedures and considers fully the strong dependencies among at least the following:

- The depot and base support levels
- The lateral resupply policies

- The transportation policies that consider costs and criteria for expediting shipments.

The Air Force then needs to test this new process in conjunction with DRIVE operating procedures for either the current DRIVE CONOPS or a modified push system. A live test is not possible because we cannot replay a live exercise in all ways except for policy. Thus, we propose a multi-echelon, multi-indenture simulation test bed of the supply, maintenance, and transportation systems that can be replayed with real demand data to test and evaluate alternative methods and processes for implementing a specific DRIVE option. This test bed would help in the following ways:

- It would provide insights into how a modified push DRIVE should operate.
- It would address other related issues to determine what the integrated logistics system of the future should look like.

CHAPTER 5

FINDINGS AND RECOMMENDATIONS

This chapter summarizes the findings of the DRIVE/UMMIPS study and provides recommendations, where appropriate. When we make recommendations, we place them after the discussions of findings that are grouped into three sections:

- Item manager's contribution to the current UMMIPS
- DRIVE's support for other than Air Force units
- DRIVE's support to Air Force units.

ITEM MANAGER'S CONTRIBUTION TO THE CURRENT UMMIPS

Item managers routinely override the UMMIPS priorities:

- They provide less support to FMS than called for under UMMIPS priorities.
- They provide more support to the depot overhaul program than a pure UMMIPS allocation would give.
- They provide better aircraft availability in peacetime and wartime for Air Force units.

Thus, item managers appear to have access to the most recent information on relative needs among the four major claimants, and they allocate assets accordingly even when their allocations violate UMMIPS priorities.

Recommendation. We recommend the following actions:

- Item managers must continue to be key players in defining the "must fill" requirements for DRIVE's pseudo bases.
- DRIVE systems should be developed to make item managers file maintenance for DRIVE's pseudo bases as simple as possible.

DRIVE'S SUPPORT FOR OTHER THAN AIR FORCE UNITS

DRIVE was originally designed to address how a subset of total support capability should be allocated across Air Force units and *not* how the total support

capability should be divided among Air Force units, the depot overhaul program, FMS, and other Services.

DRIVE's subsequent attempts to address the overall allocation problem (by including the last three of the above claimants as pseudo bases and letting them compete with Air Force units) has failed because the logistics community has not yet developed good criteria for balancing support across the four major claimants. Even UMMIPS appears to be inadequate, inasmuch as item managers routinely override UMMIPS priorities for the depot overhaul programs and FMS.

Recommendation. We recommend the following actions:

- The Air Force should develop criteria for setting priorities for allocations among pseudo bases and Air Force bases.
- Until suitable criteria are developed for balancing support across the four major claimants, we believe the Air Force should continue to use item manager expertise and the current practices to determine how much support must be provided to the pseudo bases (the depots, FMS, and other Services) and then let DRIVE determine how to distribute the remaining assets across Air Force units.

DRIVE'S SUPPORT TO AIR FORCE UNITS

Our analysis has shown that the current plans for implementing DRIVE would result in marginal improvements in aircraft availability in peacetime and wartime over a UMMIPS program that has extensive item manager intervention; however, those marginal improvements would be made without requiring item manager intervention. Thus, item managers would be able to pay greater attention to other aspects of their job, such as identifying "must fill" requirements for the depot overhaul program, FMS, and other Services.

These improvements are summarized below. (The numbers in parenthesis are the improvements relative to a Pure UMMIPS, i.e., UMMIPS without item manager intervention):

- 1 to 3 (5 to 24) percent reduction in the total number of ENMCS aircraft
- 2 to 7 (8 to 14) percent reduction in the number of ENMCS aircraft that are above their wartime ENMCS target goals

- 1 to 4 (3 to 27) percent improvement in the distribution of ENMCS shortages against goals across all bases.

On the other hand, if DRIVE is used to set priorities for MICAP requisitions only and then allowed to push all remaining assets (a modified push DRIVE), the Air Force can realize the improvements, relative to UMMIPS with item manager intervention, noted below. (Again, the numbers in parenthesis are the improvements relative to a Pure UMMIPS without item manager intervention):

- 8 to 17 (16 to 25) percent reduction in the total number of ENMCS aircraft
- 38 to 41 (39 to 49) percent reduction in the number of ENMCS aircraft that are above their wartime ENMCS target goals
- 10 to 30 (14 to 34) percent improvement in the distribution of ENMCS shortages against goals across all bases.

A comparison of the above statistics with those that are likely to result from implementing the DRIVE CONOPS shows that the current plans for implementing DRIVE would sap much of its power. The greatest benefits of DRIVE come from implementing it in a push mode, unconstrained by requisitions.

Recommendation. We recommend that in the near term, the Air Force proceed with its current plans to implement DRIVE and develop a simplified approach for setting priorities for outstanding requisitions.

We also recommend that for the longer term, the Air Force pursue a capability to implement DRIVE so that it conforms with peacetime practices to give highest priority to MICAPs but is thereafter unconstrained by requisitions. To do that, the Air Force must do the following:

- Develop base-specific application data
- Develop policies for lateral resupply that complement a modified push DRIVE described above and the retail information systems that routinely perform lateral resupply and redistribution
- Re-examine the level setting process in D028 to determine the proper support depot levels that are consistent with a modified push system and specified lateral resupply polices noted above.

In order to test the system, the Air Force should develop a multi-echelon, multi-indenture simulation test bed of the supply, maintenance, and transportation systems that can be replayed using live demand data to test and evaluate alternative methods, processes, and procedures for implementing a push policy. This test bed would help:

- Provide insights into how a modified push DRIVE should operate
- Address other related issues to determine what the integrated logistics system of the future ought to look like.

APPENDIX A

RESULTS OF ANALYSIS - TABLES

RESULTS OF ANALYSIS – TABLES

This appendix contains the results of the study analysis in tabular form. The description of the allocations that goes across each table is presented in Chapter 2 – The Experiment. A description of the metrics in the left-hand column is also provided in Chapter 2 – Evaluation Criteria and Metrics.

TABLE A-1

90-DAY ANALYSIS (ALL AIRCRAFT)

Measures of maintenance	UMMIPS		DRIVE				All levels filled
	Pure	Actual	CONOPS	Pri-Reqs	Pure	Pure Constrained	
Peacetime							
ENMCS excesses	243.8	226.7	223.5	212.4	193.4	205.5	177.3
RMSEE	2.38	2.26	2.16	2.04	1.83	2.03	1.87
Wartime							
Total wartime ENMCS	344.8	333.2	323.6	315.7	266.8	278.5	255.9
ENMCS excesses	94.5	91.7	85.6	78.1	45.8	56.8	56.5
RMSEE	2.27	2.24	2.15	2.04	1.14	1.41	1.83

Note: UMMIPS = Uniform Materiel Movement and Issue Priority System; DRIVE = Distribution and Repair in Variable Environments; ENMCS = expected number of not mission capable supply; RMSEE = root mean squared excesses.

TABLE A-2

90-DAY ANALYSIS (F-15)

Measures of maintenance	UMMIPS		DRIVE				All levels filled
	Pure	Actual	CONOPS	Pri-Reqs	Pure	Pure Constrained	
Peacetime							
ENMCS excesses	57.4	51.6	52.8	47.1	45.0	49.6	32.3
RMSEE	3.32	3.15	2.91	2.38	2.19	3.07	1.91
Wartime							
Total wartime ENMCS	77.2	70.6	68.0	63.6	61.8	67.4	36.3
ENMCS excesses	14.4	12.5	10.0	6.3	5.0	11.2	2.1
RMSEE	1.91	1.71	1.27	0.74	0.69	1.63	0.45

TABLE A-3

90-DAY ANALYSIS (F-16)

Measures of maintenance	UMMIPS		DRIVE				All levels filled
	Pure	Actual	CONOPS	Pri-Reqs	Pure	Pure Constrained	
Peacetime							
ENMCS excesses	166.1	155.8	151.6	145.6	131.3	139.4	129.5
RMSEE	3.49	3.33	3.21	3.13	2.80	2.92	2.96
Wartime							
Total wartime ENMCS	242.8	238.9	232.5	228.3	188.4	194.6	23.8
ENMCS excesses	79.6	78.54	75.2	71.36	40.8	45.6	53.95
RMSEE	3.53	3.54	3.48	3.38	1.85	2.05	3.04

TABLE A-4

90-DAY ANALYSIS (C-130)

Measures of maintenance	UMMIPS		DRIVE				All levels filled
	Pure	Actual	CONOPS	Pri-Reqs	Pure	Pure Constrained	
Peacetime							
ENMCS excesses	21.41	19.39	19.13	19.85	17.1	16.7	15.5
RMSEE	0.4	0.34	2.91	2.38	2.19	0.27	0.27
Wartime							
Total wartime ENMCS	24.78	23.78	23.06	23.79	16.73	18.24	18.24
ENMCS excesses	0.5	0.5	0.5	0.5	0	0.5	0.5
RMSEE	0.07	0.07	0.07	0.07	0	0	0.07

TABLE A-5

270-DAY ANALYSIS (ALL AIRCRAFT)

Measures of maintenance	UMMIPS		DRIVE				All levels filled
	Pure	Actual	CONOPS	Pri-Reqs	Pure	Pure Constrained	
Peacetime							
ENMCS excesses	296.0	244.4	240.5	228.7	202.1	225.5	183.4
RMSEE	2.87	2.34	2.24	2.13	1.87	2.06	1.89
Wartime							
Total wartime ENMCS	397.5	348.3	345.4	330.6	265.9	289.7	261.4
ENMCS excesses	125.1	97.8	96.3	82.3	43.0	57.2	59.2
RMSEE	2.86	2.40	2.42	2.25	1.45	1.69	1.86

TABLE A-6

270-DAY ANALYSIS (F-15)

Measures of maintenance	UMMIPS		DRIVE				All levels filled
	Pure	Actual	CONOPS	Pri-Reqs	Pure	Pure Constrained	
Peacetime							
ENMCS excesses	70.0	55.8	54.6	51.1	46.2	55.3	31.0
RMSEE	3.65	3.30	2.90	2.66	2.32	2.99	1.84
Wartime							
Total wartime ENMCS	88.3	74.0	70.1	66.7	62.4	70.0	34.9
ENMCS excesses	18.7	12.9	9.4	4.6	2.8	11.0	2.1
RMSEE	2.31	1.71	1.13	0.55	0.36	1.07	0.45

TABLE A-7

270-DAY ANALYSIS (F-16)

Measures of maintenance	UMMIPS		DRIVE				All levels filled
	Pure	Actual	CONOPS	Pri-Reqs	Pure	Pure Constrained	
Peacetime							
ENMCS excesses	201.7	165.6	161.0	153.4	136.7	147.7	134.2
RMSEE	4.32	3.45	3.36	3.22	2.83	2.98	3.00
Wartime							
Total wartime ENMCS	281.2	247.5	247.2	236.6	185.3	197.8	205.7
ENMCS excesses	105.8	84.3	85.9	76.8	40.1	48.2	56.4
RMSEE	4.48	3.82	3.97	3.74	2.41	2.54	3.09

TABLE A-8

270-DAY ANALYSIS (C-130)

Measures of maintenance	UMMIPS		DRIVE				All levels filled
	Pure	Actual	CONOPS	Pri-Reqs	Pure	Pure Constrained	
Peacetime							
ENMCS excesses	24.2	23.0	24.9	24.2	19.2	22.5	18.2
RMSEE	0.44	0.39	0.45	0.41	0.34	0.43	0.31
Wartime							
Total wartime ENMCS	27.9	26.8	28.1	27.3	18.2	21.9	20.8
ENMCS excesses	.7	0.66	1.02	1.02	0	0.15	0.66
RMSEE	0.1	0.1	0.1	0.1	0	0.04	0.1

APPENDIX B

GLOSSARY

GLOSSARY

AFM	=	Air Force Manual
AFMC	=	Air Force Materiel Command
CAT	=	cannibalization threshold
CONOPS	=	concept of operations
D028	=	Central Leveling System
D035	=	Stock Control and Distribution System
D041	=	Recoverable Consumption Item Requirements System
DoDD	=	Department of Defense Directive
DRIVE	=	Distribution and Repair in Variable Environments
DSO	=	direct support objective
ENMCS	=	expected number of NMCS
FAD	=	force/activity designator
FMS	=	foreign military sales
LRU	=	line replaceable unit
MASS	=	MICAP Asset Sourcing System
MICAP	=	mission capable
NMCS	=	not mission capable for supply
NSN	=	national stock number
OST	=	order and shipping time
PAA	=	primary aircraft authorization
POS	=	peacetime operating stock
RMSEE	=	root mean squared excesses
SRAN	=	stock record account number

SRU	=	shop replaceable unit
UMMIPS	=	Uniform Materiel Movement and Issue Priority System
UND	=	urgency of need designator
WRSK	=	war reserve spare kits
WTDOS	=	Weapon Training Detached Operating Spares

REPORT DOCUMENTATION PAGE

Form Approved
OPM No. 0704-0188

1. AGENCY USE ONLY ***(Leave Blank)***

2. REPORT DATE
March 1993

3. REPORT TYPE AND DATES COVERED
Final

4. TITLE AND SUBTITLE
A Comparison of Two Systems for Distributing Spare Parts

5. FUNDING NUMBERS
C MDA903-90-C-0006
PE 0902198D

6. AUTHOR(S)
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8. PERFORMING ORGANIZATION REPORT NUMBER
LMI-AF201R1

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
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1030 Air Force Pentagon, Room 4E260
Washington, D.C. 20330-1030

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
A: Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 words)***

The Air Force Distribution and Repair in Variable Environments (DRIVE) model is designed as an improvement over the Uniform Materiel Movement and Issue Priority System (UMMIPS) in the wholesale-to-retail distribution of reparable spare parts. This report describes and quantifies the possible improvements achieved when DRIVE is used.

The principal benefit offered by DRIVE is the ability to determine precisely and accurately the Air Force unit that has the "greatest need" for an item. That greatest need is based on current best estimates for the unit's peacetime and wartime demands and projected assets and the peacetime and wartime availability goals specified by operational commanders.

This report quantifies the benefits of the Air Force's current concept of operations (CONOPS) for implementing DRIVE. It also demonstrates how a modified "push" DRIVE allocation system could provide significant improvements over the current DRIVE CONOPS and identifies follow-on efforts that will help bring the Air Force closer to extracting the maximum benefits from the DRIVE program.

14. SUBJECT TERMS
DRIVE, UMMIPS, Distribution of Spares

15. NUMBER OF PAGES
65

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL